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SPECIFICATION

TO ALL WHOM IT MAY CONCERN:

I, Michael R. Oldenburg, a resident of Madelia, Minnesota, a Citizen of the United States of America, have invented certain new and useful improvements in an

IMPROVED SEAL FOR A SHAFT

of which the following is a specification.

Title: IMPROVED SEAL FOR A SHAFT

PRIORITY

This application is a continuation of, and clams priority to, U.S. Patent Application 09/999,654, which was filed October 31, 2001 and entitled Improved Seal For A Shaft.

TECHNICAL FIELD

Generally, the present disclosure is related to the field of seals for sealing rotary shafts. The methods and apparatus are particularly related to the field of unitary combination lip and sleeve seals. More specifically, the present invention relates to an improved seal adapted for use in severe duty applications where oil and grease must be held in contact with rotary shaft and bearing assemblies. The present invention incorporates design features that prevent the seal from wearing or cutting a groove into the associated rotary shaft, which can occur with other seals during normal operation.

BACKGROUND

The present seal structure yields a very important benefit over prior seal systems, in addition to providing most of the benefits of these seals. Previous seals, an example of which is shown in FIG. **1**, have a tendency to cut or wear a circular groove into the associated rotary shaft. Theses grooves are primarily caused by the frictional contact between the faceplate wiper ring **189** and the shaft **121**, as the shaft is rotated during normal operation of the machine. It is undesirable to have the wiper ring cutting a groove into the rotary shaft during operation because these grooves weaken the shaft and can eventually lead to cracking of the spindle. It is equally undesirable to remove the wiper ring from the seal faceplate, because the wiper ring provides an initial barrier against environmental contaminants. Therefore, the present invention alleviates the tendency of the wiper ring to cut or groove the rotary shaft, without compromising the overall seal quality.

These and further objects of the apparatus taught in accordance with this specification, the claims, and the appended drawing figures are set forth below.

SUMMARY

The present disclosure, which incorporates herein by reference in their entirety, U.S. Patent No. 6,186,507 to Oldenburg and Application 09/401,570, filed September 22, 1999, to Oldenburg, shows a retrofittable radial lip seal adapted to fit coaxially around, and reduce wear to, a circular rotatable shaft. In one embodiment, the seal comprises a first sleeve, a cylindrical seal case, a faceplate, a second sleeve and a flexible member. The first sleeve has an inner end that would normally be in contact with the grease, oil, or other fluid to be contained within a housing, an outer end opposite the inner end, a bore that has an elastomeric coating, and a first sleeve flange extending radially outward from the outer end of the first sleeve and generally perpendicular to the first sleeve axis. The first sleeve flange is terminated with an outer edge.

A cylindrically hollow seal case adapted for fitting into a bore is disposed coaxially around the first sleeve. The case is formed from a generally cylindrical case body having an outside surface, or outside diameter, that may be disposed in a bore and in contact with the wall of the bore. An elasotmeric coating may be affixed to the outside of the case body. By coating the outside of the metal case body with an elastomeric coating or layer, it is possible for the seal to securely fit a bore that may be worn or slightly damaged through use.

A case flange extends radially inwardly from, and generally perpendicular to, the longitudinal axis of the inside of the case. It is believed preferable to draw the case flange from the material of the case body. When formed in that manner, the material of the case body is doubled back on itself to yield two thicknesses of the case material for the distance between the case inner end and the case flange.

A generally planar circular faceplate has an inside surface, an outside surface, and a central aperture slightly larger than the outside diameter of the first sleeve. The plane of the inner faceplate surface is disposed generally parallel to the case skirt and the face of the first and second sleeve flanges. An elastomeric faceplate wiper ring, having at least one and preferably two main elastomeric excluding lips, can be attached to the faceplate at the central aperture so that the lips contact the outer surface of the second sleeve. The faceplate wiper ring has the ability to exclude contaminants from the remainder of the seal by contacting the second sleeve. In addition, the second sleeve and second sleeve elastomeric coating prevent the faceplate wiper ring from directly contacting the rotary shaft, and thereby prevent the wiper ring from wearing a groove into the rotary shaft during operation of the machine.

A second sleeve is located adjacent to the first sleeve and is adapted to fit coaxially around the shaft. The second sleeve has an outer end that is exposed to ambient conditions, an inner end adjacent to the outer end of the first sleeve, a bore that has an elastomeric coating, and a second sleeve flange that extends radially outward from the inner end of the second sleeve and runs generally perpendicular to the second sleeve axis. A circular elastomeric perimeter lip extends radially outwardly from the inner edge of the second sleeve flange to contact a generally cylindrical hollow seal case.

In another embodiment, the first sleeve and the second sleeve are replaced by one continuous sleeve that is adapted to fit coaxially around a shaft. In this embodiment, the seal comprises a continuous sleeve, a cylindrical seal case, a faceplate and a flexible member. The continuous sleeve has an inner end that extends into the sealed region and outer end that contacts the environment excluded by the seal. The continuous sleeve is operably positioned between the faceplate and the rotary shaft, thus preventing the wiper ring excluder lips from contacting the shaft.

In one embodiment, the seal is made into a unitary structure by inserting the first sleeve inner end through the case flange so that the first sleeve flange is positioned near the bumper. The second sleeve is then placed inside the seal case so that the perimeter lip of the second sleeve flange contacts the inside surface of the seal case outer end near the case skirt. All of the voids between the case inner flange and the case skirt can be packed with grease before final assembly of the seal. The faceplate is then attached to the case skirt thereby retaining the sleeves within the case portion. It has been found that a high quality water-resistant grease works well. One satisfactory grease is made by Esso Corporation and sold under the trade name "BEACON 325," although other products may also serve quite satisfactorily. Although it is believed preferable to attach the faceplate to the case by crimping the peripheral edge of the faceplate around the outer edge of the case skirt, the faceplate may also be attached to the skirt by welding, brazing, adhesive bonding, or by any other of the usual means of connecting such items. It is desired that the junction between the case skirt and the faceplate be impervious to external contaminants and internal lubricants at the temperatures, pressures and other conditions in which the seal was operated.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 shows a cross-sectional profile of the structure of an embodiment of a prior art seal, in which the wiper ring directly contacts the rotary shaft.

FIG. 2 shows a cross-sectional profile of the structure of an embodiment of the present invention.

FIG. 3 shows a cross-sectional profile of the structure of another embodiment of the present invention having a triple lip sealing lip.

FIG. 4 shows a cross-sectional profile of the structure of another embodiment of the present invention having one continuous sleeve.

FIG. 5 shows a cross-sectional profile of the structure of another embodiment of the present invention having an externally flangeless seal case.

DETAILED DESCRIPTION

Referring now to the various figures of the accompanying drawing, FIG. **2** depicts a cross-sectional profile of an embodiment of the seal **120**. A first sleeve, or seal sleeve, **122** is adapted to fit coaxially around a shaft **121**. The first sleeve **122** has an inner end **124** that extends into the sealed region, which normally contains oil or grease, and an outer end **126** opposite. The first sleeve bore **128** may be coated with an elastomeric coating **130** in the region between the first sleeve inner end **124** and the first sleeve outer end **126**. The optional sleeve bore elastomeric coating is desirable because it may prevent leakage from between the seal **120** and the shaft **121** even when the shaft is worn or damaged. The first sleeve flange **132** extends radially outwardly from the first sleeve outer end **126**. The first sleeve flange **132** is adjacent, and runs generally parallel to, the second sleeve flange **205** which is described below.

A seal case **150** is disposed coaxially around the outside of the first sleeve **122**. The seal case **150** has a cylindrical case body **152** designed so that the case outside surface **154** can fit into and seal against a bore in a housing or flange through which the shaft **121** to be sealed extends. It is advantageous to coat the case outside surface **154** with an elastomeric coating **156**. The optional elastomeric coating **156** helps prevent the seal **120** from leaking when installed in a damaged bore. The case body **152** has a smoothly finished perimeter lip-contacting case inner surface **158** in the region near the case outer end **160**. The case inner end **162** is axially opposite

the case outer end **160** and the case skirt **164** extends radially outwardly from the case outer end **160**.

A case flange **166** extends radially inwardly from the case body **152** towards the first sleeve **122**. The case inner flange **166** has a circular central aperture through which the shaft **121** and first sleeve **122** fit. It is preferred to form the case flange **166** from the case body in order to create a case reinforcement **168** with a double layer of material from which the case body **152** is made.

The main sealing lip **170** is attached to the case flange **166** and extends both axially and radially inwardly from the case flange **166**. The main sealing lip **170** contacts the first sleeve outer surface **172** to form a primary sealing element by which the contents (generally fluids) of the sealed volume are prevented from transferring to the outside of the assembly. The main sealing lip **170** is optionally biased against the first sleeve outer surface **172** by a garter spring **174**. The first sleeve outer surface **172** may be polished or otherwise finished to reduce wear of the main sealing lip **170**. FIG. **3** shows another embodiment of the present invention where the main sealing lip **170** has been replaced with a triple lip sealing lip **211**. In this alternate embodiment, each lip **212** of the triple lip sealing lip **211** extends axially and radially inward from the case flange **166** to contact the first sleeve outer surface **172**.

In one embodiment, a bumper **208** extends coaxially along, and radially inwardly from, the seal case **150** from the case flange **166** to contact the first sleeve flange **132**. The bumper **208** prevents the first sleeve flange **132**, and consequently the first sleeve **122**, from moving out of the desired position.

In one embodiment, a dust lip **175** extends axially outward from the main sealing lip and contacts the first sleeve outer surface **172**. Other embodiments of the present invention may contain several dust lips, all contacting either the first sleeve outer surface **172** or the first sleeve flange **132**. The case elasotmeric coating **156**, the main sealing lip **170**, the bumper **208** and the dust lip **175** may be integrally formed and bonded to the case body **152** and case flange **166** in a single injection molding operation.

A second sleeve, or face sleeve, **200** is adapted to fit coaxially around the shaft **121** and is adjacent the outer end of the first sleeve **122**. The second sleeve outer end **201** extends out into the environment excluded by the seal. The second sleeve bore **202** may be coated with an elastomeric coating **203** in the region between the second sleeve outer end **201** and the second

sleeve inner end **204**. The second sleeve flange **205** extends radially outwardly from the second sleeve inner end **204**, and runs generally parallel to the first sleeve flange **132**. The second sleeve flange **205** has a second sleeve flange inner edge **206** from which a perimeter lip **207** extends radially outwardly towards the seal case outer end **160**. In other embodiments, the perimeter lip **207** may be located on the first sleeve flange outer edge **134**. The perimeter lip **207** contacts the seal case **150** near the seal case outer end **160**. The face sleeve bore elastomeric coating **203** and the perimeter lip **207** may be formed and attached to the second sleeve **200** in a single injection molding operation.

On the inner end of the case body **152**, the case elastomeric coating **156** is finished with a case elastomeric coating chamfer **178** to make it easier to install the seal **120** without distortion or damage. A case outside relief channel **179** may be formed in the case elastomeric coating **156** adjacent to the case skirt **164**. The relief channel **179** relieves axial shear stresses from the case elastomeric coating **156** that can result when the seal **120** is installed into a bore.

A first sleeve radial channel **190** is preferably formed within the first sleeve bore elastomeric coating **130** to relieve shear as the first sleeve is fitted to a shaft. A second sleeve radial channel **216** is preferably formed within the second sleeve bore elastomeric coating **203** to relieve shear as the second sleeve is fitted to a shaft. The first sleeve **122** is finished with a sleeve outer end chamfer **192** and a sleeve inner end chamfer **194** to reduce the potential for tearing of the sleeve bore elastomeric coating **130** and for distortion of the first sleeve **122** during installation of the seal **120**. Similarly, the second sleeve **200** is finished with a second sleeve outer end chamfer **209** and a second sleeve inner end chamfer **210**. In addition, the seal case **150** may be fitted with a case inner end chamfer **196** to reduce damage to the case elastomeric coating **156** when the case is fitted with elastomeric coating and to prevent case distortion in embodiments without case elastomeric coating **156**.

The four main sub assemblies, the first sleeve **122**, the seal case **150**, the second sleeve **200**, and the faceplate **181** are interconnected to form a complete seal **120**. These four subassemblies are generally made of steel or another metal that is shaped, worked, and polished using conventional metalworking techniques and commercially available equipment. Although, any material suitable for fulfilling the functions of the seal may be used.

In one embodiment, final assembly of the seal **120** is accomplished by four additional steps. First, the first sleeve **122** is inserted into the seal case **150** so that the first sleeve flange

132 is positioned near the bumper **208.** Second, the second sleeve **200** is inserted into the seal case **150** so that the perimeter lip **207** contacts the seal case outer end **160** in the region near the case skirt **164**. Third, water resistant grease **180** is packed into all of the voids between the case flange **166** and the perimeter lip **207**. Fourth, the faceplate **181** is attached to the case skirt **164** by crimping or other means to complete the seal assembly and unitizing process.

After the faceplate **181** is attached to the case skirt **164**, the elastomeric faceplate wiper ring **189** is attached so that the wiper ring excluder lips **208** contact the face sleeve **200**. The face sleeve **200** prevents the wiper ring excluder lips **208** from directly contacting the shaft **121**, which alleviates the tendency of the wiper ring **189** to wear grooves into the shaft **121** during normal operation of the machine. The faceplate includes a central aperture larger than the outside diameter of the first sleeve, with the plane of the faceplate inner side **182** being oriented generally parallel to the case skirt **164** and the second sleeve flange **205**.

FIG. **4** shows an alternative embodiment of the seal **120** where the first sleeve **122** and the second sleeve **200** have been replaced by one continuous sleeve **213**. The continuous sleeve **213** has a continuous sleeve flange **214** that extends radially outwardly from, and generally perpendicular to, the continuous sleeve **213**.

FIG. **5** shows and alternative embodiment of the seal **120** where the seal case **150** is formed without an external flange.

While multiple embodiments are disclosed, still other embodiments of the present invention will become apparent to those skilled in the art from the above detailed description, wherein is shown and described only the embodiments of the invention, by way of illustration, of the best modes contemplated for carrying out the invention. As will be realized, the invention is capable of modifications in various obvious aspects, all without departing from the scope of the present invention. Accordingly, the drawings and detailed description are to be regarded as illustrative in nature and not restrictive.

Any references in the above detailed description to front and back, inner and outer, inside and outside, and upper and lower are intended for convenience of description, not to limit the present invention or its components to any one positional or spacial orientation.